Chapter 13

Stationarity Structure of Türkiye's Industrial Production Index

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Abstract

Industrial production is considered an important variable in monitoring the economic performance of countries. This study examines the stationarity structures of the indexes of sub-branches of industry as well as the total industrial production index of Türkiye and is a preliminary assessment for the stationarity, cointegration and causality analyses planned to be conducted on this subject in the future. While examining the stationarity structure of the indexes of sub-branches of industry and total industrial production, the series were subjected to separate analyses by taking the level values and logarithmic transformation values (1986M01-2025M02). In order to investigate the stationarity structures of the series, the Ng-Perron Unit Root Test, one of the traditional unit root tests, and the Lee-Strazicich (LS) Unit Root Test, one of the tests that take structural breaks into account, were applied and the results were reported. According to the Ng-Perron test, it was observed that the logarithmic values of the series exhibited a more stationary structure compared to the level values. According to the LS test, it was determined that both the level and logarithmic values were all stationary at the level I(0). In short, the results obtained were that the seasonally adjusted logarithmic industrial production series were generally stationary at the level, the series returned to their averages in the face of shocks, that is, the shocks were eliminated.

INTRODUCTION

In short-term economic policy analyses, industrial production stands out as an important variable. Since certain service activities are closely related to industrial activities, the industrial production sector is important in explaining significant fluctuations in the economy. For this reason, economists continue to evaluate industrial production as a leading indicator

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https://doi.org/10.58830/ozgur.pub862.c3496

of economic activity (Bruno and Lupi, 2004; Banerjee et al., 2005; Ejaz and Iqbal, 2021). Economists can use the industrial production index in total or on a sectoral basis in analyses conducted to determine production targets, monitor their development, and evaluate the functioning of the plans made (Kmietowicz, 1995). Industrial production index data is calculated to measure the outputs of the mining, manufacturing, electricity and gas services industries (Tito, 2025).

This study is a preliminary assessment in the determination of stationarity structures for studies that will include monthly data of total industrial production index and sub-branches of industry in their analyses in the coming years, specific to Türkiye. In the analyses, the study size was expanded by investigating the stationarity structures of industry sub-branches in addition to the total industrial production index. Although there are studies that conduct stationarity research based on Türkiye's total industrial production index, the absence of a study examining sub-industry branches differentiates this study from the literature. In important studies conducted for Türkiye (Ertuğrul and Soytaş (2013); Yıldırım and Kılıç (2016); Oğuz (2017)), industrial production index data are generally not stationary at the level and have become stationary by taking the differences of the series. In studies conducted for various countries around the world, as well as Türkiye (Candelon and Gil-Alana (2004); Bulligan et al. (2010); Caporale et al. (2023)), evidence has been obtained that the industrial production index series are stationary at the level or in the first difference.

MATERIAL AND METHODS

In the study, using monthly time series covering the period of January 1986-February 2025, the stationarity structures of the production indices of the industrial sub-branches (Mining and quarrying, Manufacturing industry and Electricity, gas, steam and air conditioning production and distribution) as well as the total industrial production index of Türkiye were examined. In order to determine the stationarity structures of the industrial series, the Ng-Perron test, which is one of the traditional unit root tests, and the LS test, which is one of the unit root tests that take into account structural breaks, were applied. The study data were obtained from the Turkish Statistical Institute (TSI) database and are seasonally and calendar-adjusted series (2021=100 reference year). In addition to the stationarity structure of the level values of the series, the stationarity structures of their logarithmic values were also examined. The analyzes were performed in EViews 12 and RATs software programs.

EMPIRICAL FINDINGS

Before moving on to the stationarity analysis of the industrial production index series, the diagnostic statistical results of the original values of the series are presented and evaluated in Table 1.

Table 1. Diagnostic Statistical Test Results of Series

Variable	Aver.	Med.	Max.	Min.	Std. Dev.	Skewness	Kurtosis	J-B	Prob.
TIPIt	50.60	42.80	112.50	16.50	27.58	0.70	2.22	50.76	0.00
MIN_t	63.15	58.65	104.50	34.70	18.59	0.42	2.01	33.01	0.00
MI_t	50.04	41.80	114.00	16.90	27.74	0.77	2.33	55.64	0.00
EGS_t	53.77	49.15	110.50	11.40	29.19	0.22	1.71	36.37	0.00

Abbreviations: TIPI (total industrial production index), MIN (mining and quarrying), MI (manufacturing industry), EGS (electricity, gas, steam and air conditioning production and distribution), J-B (Jarque-Bera).

The fact that the skewness coefficients of the series presented in Table 1 are greater than zero means that their distribution is skewed to the right, and the fact that the kurtosis coefficients are less than 3 means that their distribution is flatter than normal. When the probability values of the J-B test statistic are examined, it is observed that the basic hypothesis stating that the series have a normal distribution is rejected, and in this case, it is decided that they are not normally distributed. The fact that the series do not have a normal distribution indicates that they are not parametric. Since performing the analysis with nonparametric series may lead to unreliable results, the data must be transformed. At this stage, first of all, the logarithmic transformation method was applied so that the distributions of the series could become normal or close to normal. When the diagnostic statistical tests of the series whose natural logarithm (*ln*) was taken were performed again, it was observed that their skewness ($LnTIPI_t$ skewness = 0.15, $LnMIN_t$ skewness = 0.05, $LnMI_t$ skewness = 0.23, $LnEGS_t$ skewness = -0.12) (as the skewness coefficient approaches zero, it means that the series has a more normal distribution) decreased, that is, it was determined that the series had a distribution close to normal. The graphs of both the level and logarithmic values of the series are presented in Figure 1 and Figure 2, and a preliminary assessment of their stationarity structures was made.

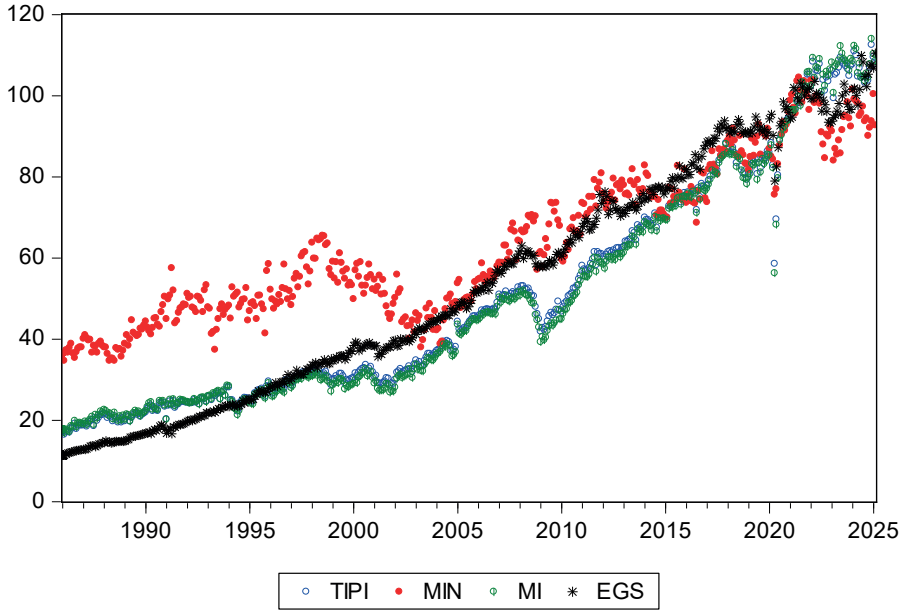

Figure 1. Time Series Graph of Level Values

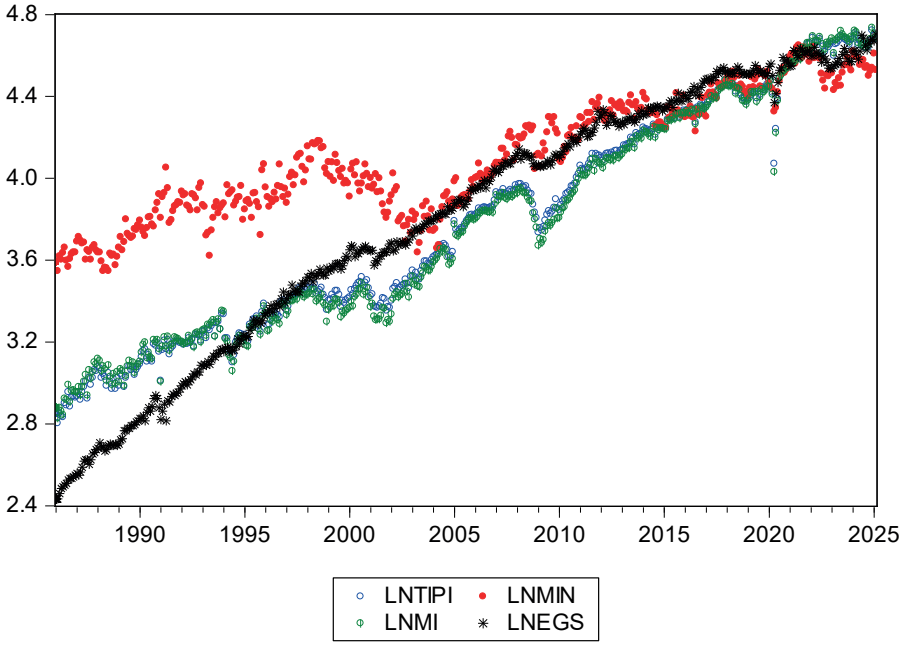

Figure 2. Time Series Graph of Logarithmic Values

When the graphs of the industrial production index time series are examined (Figure 1 and Figure 2), it is suggested that the level and logarithmic values of the $TIPI_t$, MIN_t and MI_t variables generally exhibit an image around their averages, and therefore, a preliminary idea has emerged that they may be stationary at the level. However, it is observed that the level and logarithmic time series of the EGS_t variable exhibit deviations from their averages, that is, it is thought to exhibit a more non-stationary image. In order to express with certainty whether the series contain a unit root, unit root tests were applied to both the level values and the logarithmic transformation values. The obtained stationarity results are presented and evaluated in Table 2.

Table 2. Unit Root Test Results for Industrial Production Index Series

Results for Level Values

	Ng-Perron (Intercept and Trend)				LS (Model C)	
Variable	MZ_a	MZ_t	*MSB*	*MPT*	t-stat. (TB)	5% Critical Value
$TIPI_t$	-3.53	-1.18	0.33	23.34	-7.51* (2004:11-2008:11)	-5.22
MIN_t	-33.70*	-4.10*	0.12*	2.70*	-8.88* (1997:12-2004:5)	-5.31
MI_t	-3.37	-1.14	0.34	24.17	-7.46* (2004:11-2008:11)	-5.22
EGS_t	-5.63	-1.51	0.27	15.86	-7.37* (2000:9-2017:10)	-5.41

Results for Logarithmic Values

	Ng-Perron (Intercept and Trend)				LS (Model C)	
Variable	MZ_a	MZ_t	*MSB*	*MPT*	t-stat. (TB)	5% Critical Value
$LnTIPI_t$	-36.43*	-4.26*	0.12*	2.51*	-7.13* (2000:12-2005:2)	-5.22
$LnMIN_t$	-23.66*	-3.43*	0.14*	3.89*	-8.84* (1997:12-2004:5)	-5.31
$LnMI_t$	-29.12*	-3.81*	0.13*	3.13*	-7.08* (2001:2-2008:9)	-5.41
$LnEGS_t$	-0.41	-0.24	0.57	71.20	-7.12* (2000:10-2012:2)	-5.37

Note: Ng-Perron critical values for MZ_a, MZ_t, MSB and MPT tests at 0.05 significance level are -17.300, -2.910, 0.168 and 5.480, respectively. * indicates significance at 0.05 significance level.

Ng-Perron test aims to eliminate the distortion in the volume of the error term occurring in the PP unit root test. The Ng-Perron test has modified the PP unit root test and information criteria. While the basic hypothesis

(H_0) in the MZ_a and MZ_t tests in the Ng-Perron unit root test expresses the existence of a unit root, the basic hypothesis in the *MSB* and *MPT* tests shows that the series is stationary (Ng and Perron, 2001; Çetin and Saygın, 2019). According to the Ng-Perron test results applied to the level values and logarithmic values of the industrial production series, it was determined that the MIN_t series was stationary I(0) at the level in terms of both the level values and logarithmic values. The level values of the $TIPI_t$ and MI_t series were not found to be stationary at the level, but it is noticeable that the logarithmic transformations of the series ($LnTIPI_t$, $LnMI_t$) were stationary at the level. It has been estimated that the EGS_t and $LnEGS_t$ series are not stationary at the level and the series can become stationary at least at the first difference.

LS unit root test is calculated using two models, Model A and Model C. While Model A allows two breaks at the level, Model C allows two breaks at both the level and the trend. Based on previous studies, it has been observed that Model C offers superior results compared to Model A (Lean and Smyth, 2015; Berke et al., 2014; Karademir and Evci, 2020). In the LS unit root test, the basic hypothesis states the existence of a unit root under structural breaks, while the alternative hypothesis shows trend stationarity under structural breaks (Ertuğrul and Soytaş, 2013). According to the LS unit root test results presented in Table 2, it is seen that both the level values and the logarithmic values of the industrial production index are stationary I(0) at the level. According to the LS unit root test results applied to logarithmic values, findings were obtained that the industrial production index series were trend stationary under the structural breaks in the periods of $LnTIPI_t$ 2000:12-2005:2, $LnMIN_t$ 1997:12-2004:5, $LnMI_t$ 2001:2-2008:9 and $LnEGS_t$ 2000:10-2012:2.

CONCLUSION AND EVALUATION

In the study where the stationarity analysis of Türkiye's total industrial production and the indices of industrial sub-branches was performed using monthly time series covering the period 1986-2025, the Ng-Perron test, which is one of the traditional unit root tests, and the LS test, which is one of the unit root tests that take structural breaks into account, were applied. Before proceeding to the unit root analysis of the series, it was examined whether they provided the normal distribution assumption. According to the diagnostic statistical tests performed on the level values of the series, it was determined that they were not normally distributed and their natural logarithms (*ln*) were taken to make the distribution of the series closer to normal. As a result of the logarithmic transformation, it was observed that

the skewness of the series decreased, therefore it was observed that the series had a distribution close to normal. After the series were made more ready for analysis, the unit root process was started. According to the Ng-Perron test results, the industrial production series were generally not found to be stationary at the level, but it was determined that the logarithmic values of the series were stationary at the level. According to the LS unit root test results, it was concluded that both level values and logarithmic values were trend stationary under structural breaks. In particular, it was determined that logarithmic values exhibited a more stationary structure than level values in terms of Ng-Perron unit root test results. The importance of logarithmic transformation in order for the series to have a normal distribution feature and to be made more stationary is understood from the analyses performed. The determination that the industrial production series adjusted for calendar and seasonal effects have a stationary structure means that the effects of shocks on the series are eliminated.

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